Remarks

Claims 1 to 3 are pending in the application.

Claims 1 and 2 have been amended. Paragraphs [0002] and [0010] of the Specification and the ABSTRACT have been amended for consistency with the amended claims.

Claim 2 stands objected to for use of the phrase "one-quarter-wave retardation plate" instead of the widely recognized phrase "quarter-wave retardation plate." Claim 2 has been amended as requested. Paragraph [0010] of the specification and the ABSTRACT have been amended to incorporate the recommended phrase for consistency with the amended claim.

Claims 1-3 stand rejected under 35 U.S.C. 102(b) as being anticipated by Riza (5,694,216). Examiner asserts that Riza discloses the invention as claimed: a variable optical attenuator (intended use) comprising an electrically switchable Bragg grating and a polarization-converting reflector. This reject is respectfully traversed.

The present application discloses a variable optical attenuator (VOA) intended for use in fiber optic communications systems. This VOA is comprised of a holographic polymer dispersed liquid crystal (HPDLC) Electrically Switchable Bragg Grating (ESBG) device and a polarization converting reflector that compensates for the polarization dependence of the diffraction efficiency of the ESBG.

Riza discloses a scanning interferometer comprising two Acousto-Optic Devices (AOD), commonly termed "Bragg Cells", that are used to divide a pair of incident polarized beams into undiffracted and diffracted components. These components are eventually reflected from a polarization-converting reflector such that the components pass back through the AOD. Thus Riza does contain elements similar to those claimed in the present application. However, there are differences that distinguish the present application from Riza. Most significantly, although the AOD of Riza and the Electrically Switchable Bragg Grating (ESBG) are both electrically-variable grating devices, they are substantially different components with different characteristics.

The AOD functions by launching an acoustic wave into a photoelastic substrate. The launching means is commonly a piezoelectric transducer driven with a radio frequency (RF) electrical signal. The acoustic wave creates a grating that will diffract an optical beam transmitted through the substrate. The pitch of the grating, and thus the diffraction angle, can be controlled by the frequency of the RF signal applied to the piezoelectric transducer. The strength, or diffraction efficiency, of the grating can be controlled by the RF power applied to the transducer. Thus AODs are versatile components that are commonly employed in applications such as spectrum analyzers and scanners (such as Riza) that require the ability to electrically vary the grating pitch. AODs are also used as high-speed deflectors or modulators for optical beams in applications such as optical printing. However, AODs are generally not suitable for use as VOAs for fiber optic communications systems because of high electrical power that must be applied to achieve high diffraction efficiency. For example, a typical AOD Modulator, part number H-501 by Harris Corporation, achieves a diffraction efficiency of 90% per Watt (equivalent to 10dB attenuation per Watt) of applied power, with a maximum allowable drive of

2.5 Watts (presumably required to achieve 25 dB attenuation). Such high power consumption would not be acceptable in a fiber optics communications system, where 40 or more VOAs may be used within a single compact module to equalize the strength of the channels in a wavelength-division multiplexed communications link.

The HPDLC ESBG of the present application is a grating formed in a composite of photo-curable monomer and liquid crystal materials. The grating pitch is fixed during formation, and the grating index modulation and diffraction efficiency can be controlled by varying the orientation of the liquid crystal molecules by means of an applied electric field. The ESBG VOA is an inherently low power device that can achieve high attenuation with a power consumption of no more than a few milliwatts per VOA, including the driving electronic circuitry. Thus the invention disclosed in the application is well suited for use in optical communications systems.

argue ... not the claims

In addition, Riza does not teach the use of the polarization-converting reflector as it is used in the present application for compensation of the polarization dependence of the grating device. Riza employs the polarization-converting reflector to change the polarization of the reflected beam such that the reflected beam can be separated from the incident beam by means of a polarizing beam splitter (23 in FIG. 2A). Riza is not concerned with the polarization dependence of the diffraction efficiency of the AODs since the incident beams are linearly polarized (Col. 9, lines 34-36).

Claim 1 has been amended to be specific to polymer dispersed liquid crystal ESBG devices and thus more clearly distinguish the invention from the prior art. Paragraph 0002 of the Specification and the Abstract have been amended for consistency with the amended Claim 1. Support for these amendments is found in Paragraph 0003 of the Specification.

Applicant respectfully submits that the claims are now in condition for allowance and requests that a timely notice of allowance be issued in this case.

Respectfully submitted,

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Application No. 10/074,653
Amendment dated August 25, 2003
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Appendix -- Unmarked Abstract

ABSTRACT

An apparatus is disclosed for an electrically variable optical attenuator. The apparatus is comprised of a polymer dispersed liquid crystal Electrically Switchable Bragg Grating device and a polarization-converting reflector. The polarization-converting reflector may be a quarter-wave retardation plate or a 45-degree Faraday rotation plate in combination with a mirror. The electrically variable optical attenuator is suited for use in fiber optics communications systems.